

**A REPORT OF THE AAWG  
RECOMMENDATIONS FOR REGULATORY ACTION TO PREVENT  
WIDESPREAD FATIGUE DAMAGE IN THE COMMERCIAL AIRPLANE FLEET**

**Appendix F NDI DATABASE**

On April 22nd, 1998, the Airworthiness Assurance Working Group (AAWG) generated an action item from the AAWG industry survey on technology readiness for detection of Widespread Fatigue Damage (WFD). Lockheed Martin, Airbus Industrie, Boeing, and the FAA tech Center had just given presentations on crack detectability, based on WFD occurring in four hypothetical structure configurations. The action item requested that the four industry participants coordinate their estimates into a single set of numbers for use by the committee.

The action item has been completed. Reducing NDT data into curves or numerical estimates is a risky activity. Over-simplifications of this sort can result in poor engineering decisions if used without cognizance of the many factors, which influence NDT inspections. However, the participants recognize the need for a basis on which to proceed with the committee's work.

Our response is contained in the data sheets that form a part of this Excel 4.0 file. It represents, in almost all cases, detectability under controlled (laboratory) conditions. Human factors, inspection surface conditions, operator experience level, and other variables have not been considered.

The data also represents use of the optimum NDT method. Many operators will not be using state-of-the-art equipment.

The "database" data sheet contains the individual responses from the participants. The shaded cells in the spreadsheet are those which were used to represent the industry. In most cases these are the largest of the crack sizes provided.

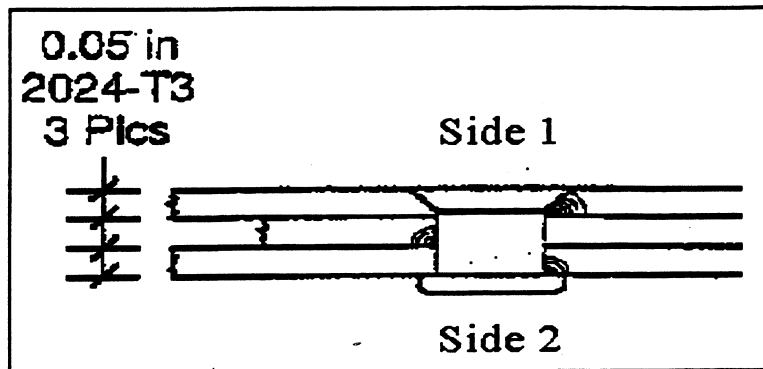
Where possible, 90/95 probability figures were used. However, these can also be subject to misinterpretation as described in the "FAA Tech Center Comment" worksheet of this file.

Assumptions and legends used in providing the estimates, other than those listed here, are shown on the data sheets themselves. The sheets should be printed out before review. Fax copies will be sent where necessary.

The estimates were provided by:

Daniel Bical (Airbus Industrie)  
Don Hagemaier & Jeff Kollgaard (Boeing Commercial Airplane Group)  
Don Pettit (Lockheed Martin Aerospace Systems)  
Chris Smith & Floyd Spencer (FAA Technical Center)

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**WIDESPREAD FATIGUE DAMAGE IN THE COMMERCIAL AIRPLANE FLEET**  
**Widespread Fatigue Damage Detectability – Database**  
(All cracks measured from shank of fastener, cracks numbered in ascending order from inspection side)  
**Case 1: Aluminum NAS1097-AD5 flush rivet**



**Side 1:**

	Boeing		Airbus Industrie		Lockheed Martin		FAA Tech Center	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
CRACK 1:			0.08	2.0	0.05	1.3	0.05	1.3
					0.035	0.9	0.032	0.8
CRACK 2:	0.2	5.1	0.24	6.0				
	0.1	2.5						
CRACK 3:	0.3	7.6			0.3	7.6	0.24	6.1
	0.15	3.8					0.12	3.0

**Side 2:** Dimension shadowed by upset rivet assumed to be 0.020" (0.5 mm).  
Rivet upset assumed to be irregular.

	Boeing		Airbus Industrie		Lockheed Martin		FAA Tech Center	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
CRACK 1:	0.083	2.1						
	0.08	2.0						
CRACK 2:	0.2	5.1	0.24	6.0				
	0.125	3.2						
CRACK 3:	0.3	7.6			0.3	7.6		

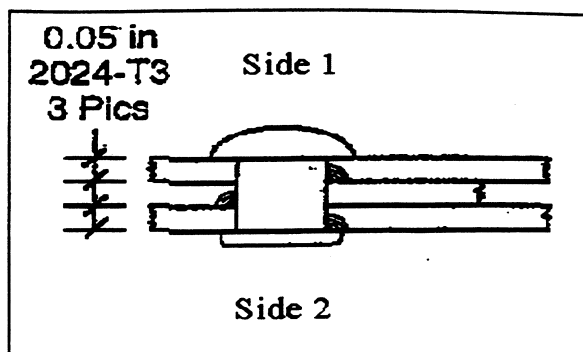
Key: current capabilities in plain text, five year projections in *italics*, 90/95 crack lengths in **bold**

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**Case 2: Aluminum MS20470 protruding head rivet**



**Side 1:** 0.078" (2.0 mm) = dimension shadowed by MS20470 protruding head

	<b>Boeing</b>		<b>Airbus Industrie</b>		<b>Lockheed Martin</b>		<b>FAA Tech Center</b>	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
CRACK 1:	0.118	3.0			0.1	2.5	0.11	2.8
	<i>0.088</i>	2.2						
CRACK 2:	0.2	5.1	0.24	6.0				
	<i>0.178</i>	4.5						
CRACK 3:	0.3	7.6	0.31	8.0				
	<i>0.228</i>	5.8						

**Side 2:** Dimension shadowed by upset rivet assumed to be 0.078" (2.0 mm).  
Rivet upset assumed to be irregular.

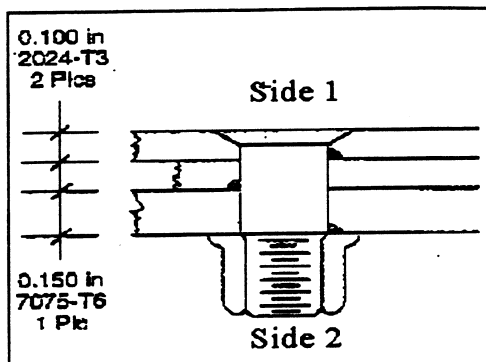
	<b>Boeing</b>		<b>Airbus Industrie</b>		<b>Lockheed Martin</b>		<b>FAA Tech Center</b>	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
CRACK 1:			0.1	2.5	0.1	2.5		
					<i>0.09</i>	2.3		
CRACK 2:	0.2	5.1	0.24	6.0				
	<i>0.188</i>	4.8						
CRACK 3:	0.3	7.6			0.3	7.6		
	<i>0.238</i>	6.0						

Key: current capabilities in plain text, *five year projections in italics*, **90/95 crack lengths in bold**

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(All cracks measured from shank of fastener, cracks numbered in ascending order from inspection side)

**Case 3: Titanium HLT-335 flush 0.250" (6.3 mm) diameter fastener**



**Side 1:**

	Boeing		Airbus Industrie		Lockheed Martin		FAA Tech Center	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
CRACK 1:	0.1	2.5	0.1	2.5				
	0.1	2.5						
CRACK 2:	0.3	7.6	0.31	8.0				
	0.15	3.8						
CRACK 3:	0.55	14.0			0.6	15.2		
	0.25	6.4					0.1	2.5

**Side 2:** Dimension shadowed by fastener collar assumed to be 0.125" (3.2 mm).  
No sealant cap present.

	Boeing		Airbus Industrie		Lockheed Martin		FAA Tech Center	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
CRACK 1:	0.125	3.2	0.12	3.0				
	0.1	2.5						
CRACK 2:			0.39	10.0	0.3	7.6		
					0.25	6.4		
CRACK 3:					0.6	15.2		
					0.5	12.7		

NOTE: Inspection for crack 3 from side 2 is a very unlikely inspection scenario.

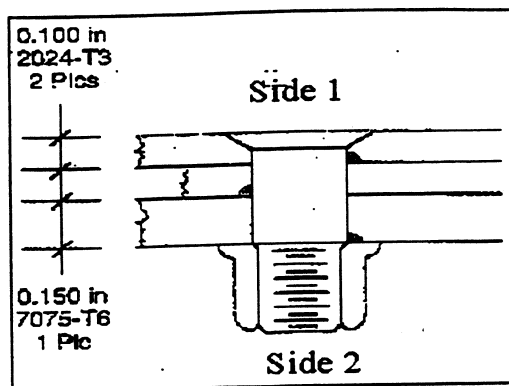
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**Case 4: Steel HLT-41 flush 0.250" (6.3 mm) diameter fastener**



**Side 1:**

	Boeing		Airbus Industrie		Lockheed Martin		FAA Tech Center	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
CRACK 1:					0.09	2.3		
CRACK 2:			0.31	8.0	0.25	6.4		
	0.15	3.8						
CRACK 3:			0.79	20.0	0.4	10.2		
	0.25	6.4					0.1	2.5

**Side 2:** Dimension shadowed by fastener collar assumed to be 0.125" (3.2 mm).  
No sealant cap present.

	Boeing		Airbus Industrie		Lockheed Martin		FAA Tech Center	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm
CRACK 1:			0.12	3.0	0.1	2.5		
					0.09	2.3		
CRACK 2:			0.39	10.0	0.25	6.4		
					0.2	5.1		
CRACK 3:					0.45	11.4		
					0.35	8.9		

NOTE: Inspection for crack 3 from side 2 is a very unlikely inspection scenario.

Key: current capabilities in plain text, five year projections in *italics*, 90/95 crack lengths in **bold**